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Ecological Notes on Male *Mydas xanthopterus* (Loew) (Diptera: Mydidae) and Their Interactions with *Hemipepsis ustulata* Dahlbohm (Hymenoptera: Pompilidae)

JAY W. NELSON

Northern Arizona University, Flagstaff, Arizona. Present address: U.S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center, 1011 East Tudor Road, Anchorage, Alaska 99503.

Abstract.—Observations of the hilltopping male *Mydas xanthopterus* (Loew) were made on a ridge near Portal, Arizona during June–August 1978. Male flies were active from sunrise until late morning, defending portions of hilltop bushes and small trees. Territories were defended prior to study initiation in late June until about 18 July after which only scattered individuals remained on the hilltop. Territorial aggressiveness was directed toward all nearby flying objects. The co-occurring wasps *Hemipepsis ustulata* Dahlbohm and *Polistes canadensis* (Cresson) also defended sites on the hilltop. *H. ustulata* males more aggressively defended their territories against *Mydas* males than against *Polistes* males, possibly due to mimetic similarity of *Mydas* to *Hemipepsis*.

The biology of flies of the family Mydidae is little known (Borrer et al., 1976), although this uncommon group is widespread in the warmer areas of the world. Biological information in taxonomic works by Wilcox and Papavero (1971) and Papavero and Wilcox (1974) and scattered descriptions of larval forms make up the bulk of the recent literature on this group (e.g., Genung, 1959; Krivosheina, 1977).

Male territorial behavior was discussed by Norris (1938), and Zikan (1942), both of whose published accounts of mydids included mention of mating systems resembling leks. Meyers et al. (1984) recently noted the superficial similarity of *Mydas xanthopterus* (Loew) and tarantula hawk wasps, specifically *Pepsis formosa* Say. This paper describes seasonal and daily activity patterns of *Mydas xanthopterus* (det. by J. Wilcox) males and relates that to the male's reproductive role. In addition the interactions and possible mimicry between *M. xanthopterus* and the tarantula hawk wasp, *Hemipepsis ustulata* Dahlbohm, are discussed.

METHODS

The study site consisted of three hills along the backbone of an 1800 meter mountaintop, 1.5 km south of Portal, Arizona in the Coronado National Forest. To the east, west and north, the terrain dropped steeply away to a dry plain of 1100 to 1500 meters in elevation. From the study site the ridgeline rose gently to the south culminating in 2600 m Portal Peak, 3.5 km to the south. Vegetation at the hilltop site consisted of scattered trees and shrubs with a sparse ground

cover of annuals and perennial grasses characteristic of the upper Chihuahuan desert (Lowe, 1964; Linsley and Cazier, 1972).

Observations of *Mydas* activity were made between 30 June and 23 August 1978, incidental to and coincident with studies of the behavior of *Hemipepsis* males (Nelson, 1986). Each male *Mydas* defended a territory consisting of a small bush or portion of a shrubby tree along the hilltop study site. Daily and seasonal activity patterns of *Mydas* males were obtained from records of interspecific encounters between *Mydas* and color-marked *Hemipepsis* males during behavioral studies of the latter species. None of the 20 to 30 *Mydas* males present on the one hectare study site were marked. Observations were made primarily between sunrise and noon when study animals were most active.

Results

Mydas xanthopterus were found only near the tops of three hills along the ridge at the study site (n = 20–30). Ten *Mydas* were collected and sexed; eight were males. Males exhibited evidence of hilltopping behavior (Shields, 1967; Downes, 1969; McFarland, 1976) by perching on the tops of chihuahua pines (*Pinus leiophylla*), one-seed juniper (*Juniperus monosperma*), and several species of scrub oak (*Quercus* spp.), and aggressively investigating flying objects such as other insects, birds, or even small stones. Exclusive use of these perches and territory sites by resident males was taken as further evidence of "classic" hilltopping behavior (McFarland, 1976).

H. ustulata are known to use hilltopping as a reproductive strategy (Alcock, 1981). Each *Hemipepsis* male at the study defended a small bush or tree against intruders much as did *M. xanthopterus*. However *Mydas* territories were smaller and thus several *Mydas* males were frequently present within the territory of one *Hemipepsis* male. *M. xanthopterus* bear a strong resemblance to *Hemipepsis ustulata* in terms of body color (black), wing color (orange), and body size. *M. xanthopterus* antenna are long and wasplike, further accentuating the similarities. There was evidence that *H. ustulata* males were fooled by this superficial resemblance.

Encounters between *Mydas* and *H. ustulata* males often involved chases of long distance and duration as well as mid-air clashes. Male encounters usually began when the male of one species flew out from its perch, either spontaneously or aggressively towards another flying object. Adjacent males then flew out in response, following the first male. Upon close approach and investigation one male then typically broke off the encounter, soon returning to its territory. However the length of each pairwise encounter in both time and distance varied between various species pairs. Both *Hemipepsis* males and *Polistes canadensis* (Cresson) males were involved in two-way and three-way conflicts with *Mydas*. A record of intra- and interspecific clashes between *Hemipepsis-Hemipepsis, Hemipepsis-Mydas,* and *Hemipepsis-Polistes* (Table 1) showed that the intensity of the territorial encounters as measured by the length in distance of each territorial chase was distinctly different for each couplet of combatants. As one might expect, the intraspecific *Hemipepsis* encounters were of longer distance than similar encounters with the other two species (ANOVA, $P < 0.05$). However, encounters between *Hemipepsis* and *Mydas* males were also significantly greater in distance than *Hemipepsis-Polistes* encounters.

Table 1. Number and percentage of male-male territorial chases (>4 m) between *Hemipepsis* and three species of flying insects. Territorial flights are summarized from June–July 1978.

Species	Total territorial flights	No. flights >4 m in length	% flights >4 m in length
Hemipepsis-Hemipepsis	140	75	53.6
Hemipepsis-Mydas	59	15	25.4
Hemipepsis-Polistes	1164	69	5.9

I recorded the number of territorial defense flights/hour by *Hemipepsis* and the reasons for those flights. Fewer than 10% of those flights were in response to *Mydas*. We can infer seasonality of *Mydas* males from this data (Fig. 1). Peak numbers of territorial defense encounters occurred between *Mydas* and *Hemipepsis* between 9 and 17 July, dropping to almost nil after 18 July. Data for one 9 day period prior to the peak activity indicate fewer territorial encounters. No data were collected prior to 30 June but *Mydas* males were observed on the study site at least as early as 23 June.

Daily numbers of territorial encounters between *Hemipepsis* and *Mydas* peaked between 0700 and 0800 Mountain Standard Time (MST) even though territorial defense flights by *Hemipepsis* males did not reach a maximum until 0900–1000 MST (Fig. 2). It can be reasonably inferred that the rate of *Hemipepsis-Mydas* encounters reflected the *Mydas* territorial activity with a 3 hour period in the morning as well as a period of activity beginning after 1200 MST. *Mydas* males (and *Hemipepsis* males) are only active on afternoons characterized by cooler temperatures following morning thundershowers or heavy clouds. In general, fewer *Mydas* were active during the afternoon period.

Discussion

Hilltopping.—Males of *Mydas xanthopterus* may employ hilltopping as a strategy to secure mates. Shields (1967) clearly shows the reproductive nature of hilltop sites for butterflies, the main advantage being to facilitate encounters between the sexes. Downes (1969) viewed hilltopping as merely a special case of the well known tendency of many insects to be attracted to "optical markers" for the purposes of breeding. Competition for dominance within a reproductive assemblage of males, and greatly skewed sex ratios are identifying characteristics of such lek territoriality (Emlen and Oring, 1977). Hilltopping exhibits these key characteristics. However, the development of hilltopping in *M. xanthopterus* represents only one solution to the problem of acquiring mates. Numerous other species of at least 4 genera of Mydidae inhabit the locality of the study site; only this species and one other were observed in the vicinity of hilltops.

Another possible meeting place for rare and/or widely scattered species of Mydidae would be at food sources. Not much is known of the feeding habits of adults, although Genung (1959) stated that adult Mydidae are known predators of insects. Meyers et al. (1984) collected specimens of *Mydas xanthopterus* on food plants in the Chiricahua Mountains 25 km E of my study site. It is possible that site was also used for mating. Zikan (1942) found *Mydas* spp. males but never females feeding on flowers, a situation which suggests the skewed sex ratios typical of mating arenas. This apparently was not true for *M. xanthopterus* since

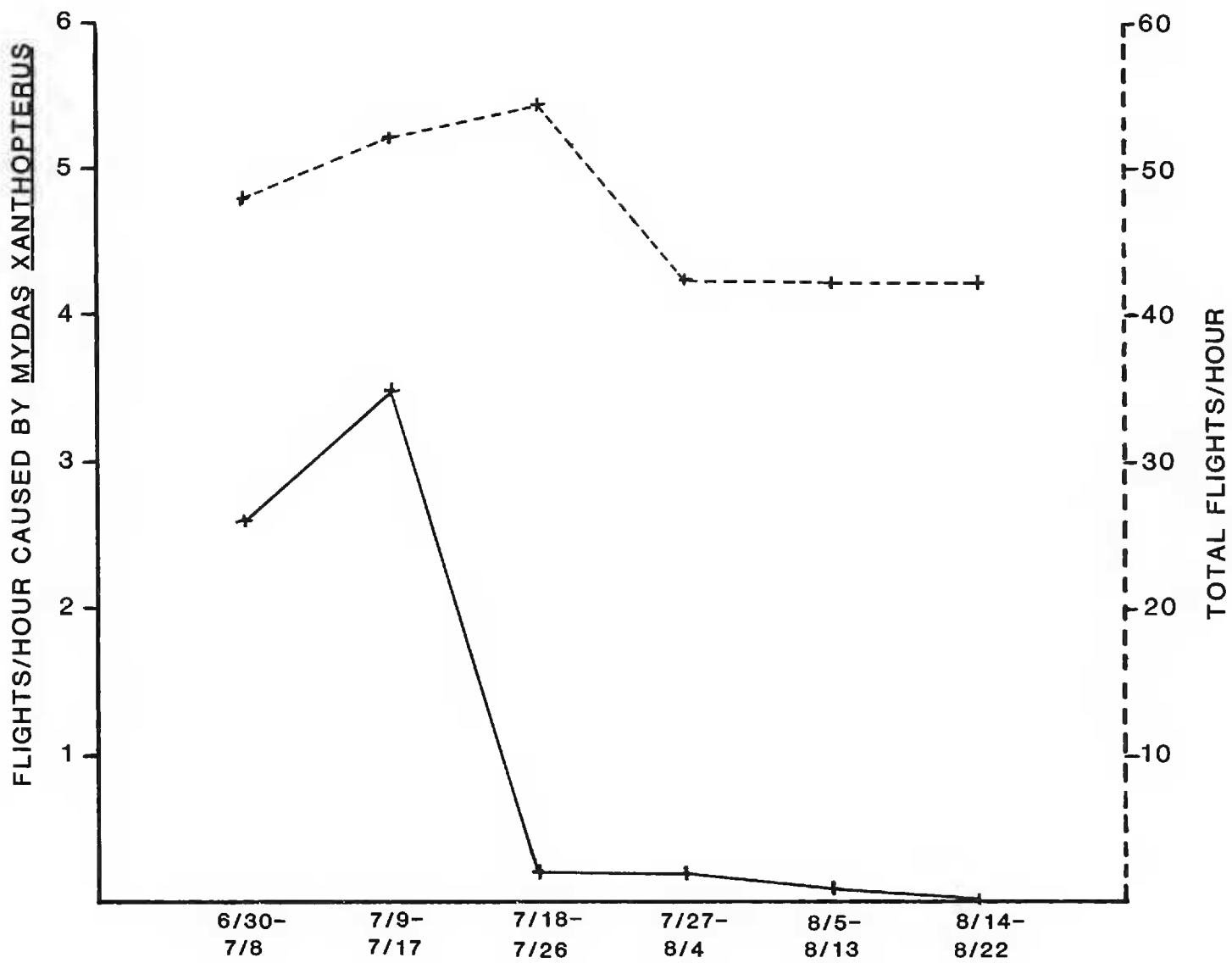

Figure 1. Seasonal variation in the total number of *Hemipepsis ustulata* territorial defense flights/hour (dashed line), and the number of *Hemipepsis* territorial defense flights/hour caused by *Mydas xanthopterus* (solid line).

Meyer et al. (1984) reported approximately equal numbers of male (5) and female (4) flies collected at the feeding site. If the flower patch were used as a mating site one might expect a skewed sex ratio. However in the megachilid bee *Anthidium maculosum* males defend patches of flowers and both sexes mate promiscuously (Alcock et al., 1977). Sex ratios in that case are closer to unity.

One advantage hilltopping may confer is a means of avoiding confusion among males and females of closely related species all trying to mate at the same location. Hilltopping could be viewed as one workable, alternative mating system with the principle advantage of spacial separation from the mating aggregations of related species that may use different mechanisms for mating. Seasonality and diurnal periodicity may further reproductively isolate *M. xanthopterus*. Figure 1 suggests that most reproductive activity is completed by late July; daily activity of males seems to be restricted to the cooler parts of the day (Fig. 2). Hilltopping as a reproductive strategy is also useful for those species whose larval forms are widely scattered, as mydid larva probably are. Nothing has been published on the larval foods of *M. xanthopterus*; however other species of Mydidae are suspected of having juvenile forms which are predatory of coleopterous larva (Genung, 1959; Krivosheina, 1977). Such a mode of existence which would necessitate a wide

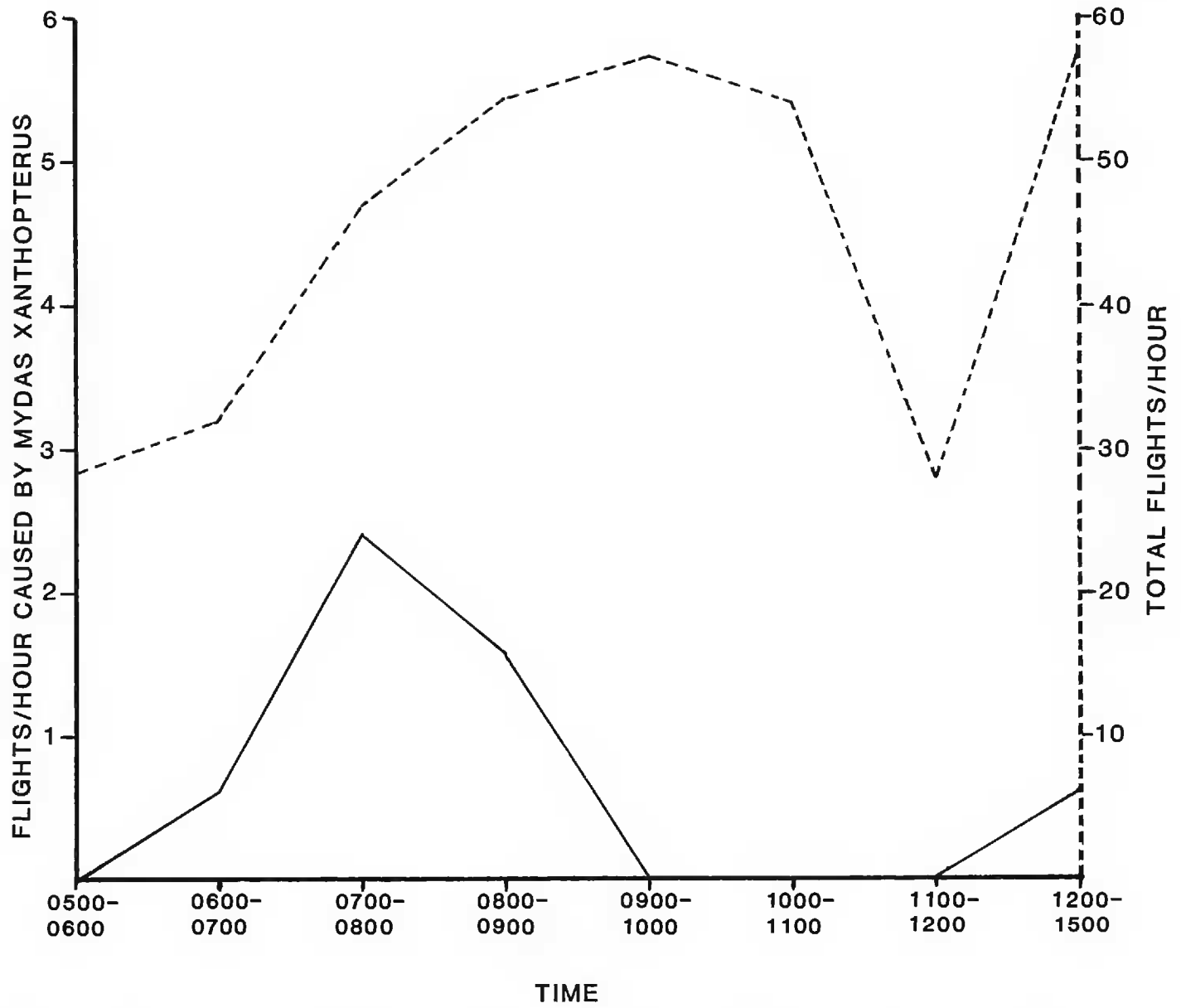

Figure 2. Daily variation in the total number of *Hemipepsis ustulata* territorial defense flights/hour (dashed line), and the number of *Hemipepsis* territorial defense flights/hour caused by *Mydas xanthopterus* (solid line).

dispersion of larva. Particular preference by Mydidae larvae has been shown for sandy soils (Steyskal, 1956; Genung, 1959; Wilcox and Papavero, 1971), an abundance of which occurs in the vicinity of the study site. Thus, when adult *Mydas* emerge, probably asynchronously, finding mates may involve a difficult and time-consuming search without some reproductive mechanism such as hilltopping. For relatively rare species such as *Mydas xanthopterus,* such a strategy becomes even more important.

Mimicry.—Mydidae have previously been noted as mimics of pompilid and other species of wasps (Howard, 1907; Zikan, 1942, 1944). Meyer et al. (1984) noted the marked resemblance of *M. xanthopterus* to the co-occurring *Pepsis formosa.* Zikan (1942) recorded *Mydas* spp. males trying to mate with large black Pompilidae, which they seem to mimic. J. Wilcox (in litt.) examined a *M. xanthopterus* specimen on which a note stated that the fly closely resembled *Pepsis thisbe* (Lucas), a pompilid similar in appearance to *Hemipepsis.*

Polistes-Hemipepsis encounters rarely (5.9%) resulted in long chases. One might reasonably expect that territorial defense flights between these two pugnacious species would involve encounters more aggressive than those between the distantly related *Hemipepsis* and *Mydas* (Nelson, 1986). This suggests that *Hemipepsis*

males reacted to the superficial similarity between themselves and *Mydas* males with the resulting intense (longer in time and distance) territorial defense encounters. However, other possibilities exist that could adequately explain the levels of aggression (as defined by territorial defense chases greater than 4 meters): 1) Because of the large number of *Hemipepsis-Polistes* encounters (Table 1), the combatants may have become habituated to each other and as a result, engaged in more passive territorial defense, or 2) *Mydas* may be a stronger flier than *Polistes,* thereby drawing *Hemipepsis* into longer pursuits. In the first case, however, encounters between *Polistes* males and *Hemipepsis* males were not longer early in the morning before habituation presumably would have occurred (Nelson, 1986). Flights between those two species were invariably short in distance. For the second possibility, both *Polistes* and *Mydas* are relatively strong and aggressive fliers. Casual observations did not reveal any behavioral traits that would account for the relative lengths of territorial defense flights except that *Hemipepsis* males appeared to exhibit more interest in the visually more similar *Mydas* flies.

Female *Hemipepsis* defend themselves with a powerful sting; at least some predators probably avoid them as a result. Therefore, successful mimicry of pompilid wasps by *M. xanthopterus* would presumably increase their adult survival. The close associations of pompilids and *M. xanthopterus* noted in at least two situations (Meyers et al., 1984; present study) might help maximize the many advantages conferred by mimicry by providing a larger number of appropriate mimics for predators to see. And in this case the male *Hemipepsis* could themselves be considered mimics of conspecific females, part of the large number of insects that use presumed mimetic advantage of black and orange. Whatever selective advantages accrue to *Mydas* males through pompilid mimicry could well be similar to advantages that accrue to *Hemipepsis* males from their resemblance to *Hemipepsis* females.

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